

Appl. No.: 10/657,730
Amdt. dated 7/3/06
Reply to Office Action of January 3, 2006

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REMARKS/ARGUMENTS

As explained more fully below, Applicant has amended independent Claims 1, 26, 57 and 73, and the claims depending therefrom, to more clearly define the claimed invention. Applicant requests reconsideration of Claims 1-16, 26-40, 57-67, and 73-82 in view of the Amendments and Remarks set forth herein.

Invention

The present invention is directed to beneficiating slag and, more specifically, slag generated by the gasification of carbonaceous solids. Slag generated by gasification of carbonaceous solids comprises molten or partially fused particles that come into contact with the furnace wall, become chilled, and solidify. This slag is generally much denser than either fly ash or bottom ash, which are by-products from coal combustion. The coarse component of the slag is essentially a coarse vitreous, high density, abrasive solid that is low in carbon content. The physical shape of the coarse slag particles ranges from rod or needle-like structures to irregular-shaped jagged pieces. The finer slag is comprised of char or unburned carbon particles containing varying amounts of siliceous ash. The carbonaceous phase of the ash is irregularly shaped particles with a highly developed pore structure.

Slag is generally not usable when it comprises a mixture of coarse, vitreous material and fine, porous carbon material, such as when the slag is removed from the gasifier. The inventors of the present invention are believed to be the first to have invented a method and apparatus for economically beneficiating the slag generated by the gasification of carbonaceous solids into useful components with acceptable quality and sizing for specific end use markets.

The Rejection Under 35 USC § 112, Second Paragraph, Should Be Withdrawn

The Office Action rejected Claim 5 under 35 U.S.C. § 112, second paragraph, asserting that Claim 5 is vague and indefinite because it is not clear as to what "mixing step" is referred since there is more than one mixing step. Applicant disagrees. Claim 5 depends from

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independent Claim 1, which recites a single mixing step, *i.e.*, “mixing the slag with water to form a slurry....” Applicant respectfully submits that its mixing step being referred to is clear and, thus, the rejection under 35 U.S.C. § 112, second paragraph, should be withdrawn.

The Office Action rejected Claim 11 under 35 U.S.C. § 112, second paragraph, asserting that Claim 11 is vague and indefinite because it is unclear what qualifies a “fuel product” and an “adsorbent carbon”. Applicant has amended dependent Claims 11, 16, 35, 40 to recite a “carbon-based combustible fuel” in place of “fuel product”. Regarding the assertion that “adsorbent carbon” is vague and indefinite, Applicant disagrees. As evidence by the webpage attached at Exhibit A hereto, the Glossary provided by the Carbon Sequestration Leadership Forum website located at the URL www.cslforum.org indicates that “adsorbent carbon” means “[a]morphous solid carbon materials (as opposed to diamonds) physically attract and bind CO₂ onto their surface and can be used to capture CO₂ from a gas stream. Amorphous carbon materials produced in different ways have different surface structures and different adsorption properties. Potentially, carbon absorbents can capture and release CO₂ with very little energy required because there is no chemical reaction involved.” Accordingly, Applicant respectfully submits that the meaning of the term “adsorbent carbon” is not vague or indefinite, but is well known to those of ordinary skill in the art. In light of the amendment to Claim 11 and the remarks and evidence set forth herein, Applicant respectfully requests that the rejection of Claim 11 under 35 U.S.C. § 112, second paragraph, be withdrawn.

The Rejections Under § 103 Directed to the Claims Are Overcome

The Office Action rejects Claims 1-4, 8, 57-60 under 35 U.S.C. § 103(a) as being obvious over U.S. Patent No. 5,427,607 to Cristovici in view of U.S. Patent No. 4,972,956 to Coleman. The Office Action rejects Claims 5-6, 9-12, 14, 26-31, 33-36, 38, 61, 63-66, 73-77, and 79-81 under 35 U.S.C. § 103(a) as being obvious over the Cristovici ‘607 patent in view of the Coleman ‘956 patent in further view of U.S. Patent No. 3,851,827 to Carignani. The Office Action rejects Claims 7, 32, 62 and 78 under 35 U.S.C. § 103(a) as obvious over the Cristovici ‘607 patent in view of the Coleman ‘956 patent in further view of U.S. Patent No. 5,992,641 to

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Caldwell. The Office Action rejects Claims 15-16, 39-40, 67 and 82 under 35 U.S.C. § 103(a) as being obvious over the Cristovici '607 patent in view of the Coleman '956 patent in view of the Carignani '827 patent and further in view of U.S. Patent Publication No. 2001/0033823 to Kuniyoshi. To the extent that the rejections would be applied to the claims, as amended, Applicants would respectfully traverse.

The Office Action rejects independent Claims 1 and 57 as being obvious over the Cristovici '607 patent in view of the Coleman '956 patent and rejects independent Claims 26 and 73 as being obvious over Cristovici '607 patent in view of the Coleman '956 patent and further in view of the '827 patent to Carignani. The Cristovici '607 patent discloses a method of recovering metallic iron from slags and other residues. Recovery of metallic iron from slags formed when iron, steel and various ferrous alloys are handled in a molten state is quite different from the beneficiation of coal products, such as fuel and adsorbent carbon, from coal gasification slag.

The Coleman '956 patent discloses a method and apparatus for removing pyritic sulphur from carbonaceous particles. As taught by Coleman, the method and process involves violently mixing the slurry using high shear mixers, aerating the slurry, separating the buoyant micro-agglomerates by a skimmer belt, and removing trapped water containing minor amounts of pyritic sulphur and other inorganic substances.

The Carignani '827 patent discloses a method and device for transforming slurries coming from wet purification plants for fumes from blast furnaces and basic oxygen furnaces into a controlled size granular solid material. Specifically, the Carignani '827 patent is directed at treating generally slimes coming from industrial metal operations, particularly steel operations. As noted above with respect to the Cristovici '607 patent, processing slurries comprising metallic materials is quite different from the beneficiation of coal products, such as fuel and adsorbent carbon, from coal gasification slag.

Regarding the combination of the Cristovici '607 patent and the Coleman '956 patent and the Cristovici '607 patent, Coleman '956 patent, and Carignani '827 patent, Applicants submit that a person of ordinary skill in the art would have no reasonable motivation to combine the

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teachings of these references, as proposed in the Office Action. *See In re Rouffet*, 149 F.3d 1350, 1357, 47 USPQ2d 1453, 1457-58 (Fed. Cir. 1998) (The combination of the references taught every element of the claimed invention, however without a motivation to combine, a rejection based on a *prima facie* case of obvious was held improper.) In this regard, there is no explicit suggestion in any of the cited references regarding the desirability for the combination proposed in the Office Action, nor does the Office Action identify any such explicit suggestion. Moreover, two of the references, *i.e.*, the Critovici '607 patent and Carignani '827 patent, are directed to methods and apparatus for processing of slurries with metallic constituents, while the other reference, *i.e.*, the Coleman '956 patent, is directed to a method and apparatus for removal of pyretic sulphur from carbonaceous particles. Not only does it appear that the Critovici '607 patent and Carignani '827 patent are directed to non-analogous art, but given the disparate teachings and fields of the Critovici '607 patent and Carignani '827 patent on the one hand, and the Coleman '956 patent on the other hand, Applicants submit that there is no implicit suggestion to combine the references either, as one of ordinary skill in the art would be expected to have knowledge relating to processing slurries comprising coal gasification and coal combustion by-products, but not processing slurries with metallic constituents. *See In re Kotzab*, 217 F.3d 1365, 1370, 55 USPQ2d 1313, 1317 (Fed. Cir. 2000) ("The test for an implicit showing is what the combined teachings, knowledge of one of ordinary skill in the art, and the nature of the problem to be solved as a whole would have suggested to those of ordinary skill in the art."). Thus, respectfully, it appears that the only reason for combining of the cited references is Applicants' own patent specification, which is not a proper reason for combining of references.

Applicants further submit that the proposed combinations of the Critovici '607 patent and the Coleman '956 patent and the Critovici '607 patent, Coleman '956 patent, and Carignani '827 patent do not meet every limitation of the patent claim and, thus, does not render the claimed invention obvious. In this regard, Applicants have amended independent Claims 1, 26, 57, and 73 to clarify that the slag being beneficiated comprises slag from coal gasification. None of the cited references teaches or suggests the steps of mixing a slag from coal gasification to form a slurry, as recited in independent Claims 1 and 26, or screens for removing first and second

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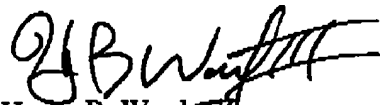
portions of material from a slurry comprising slag from coal gasification, as recited in independent Claims 57 and 73, as amended. In contrast, the Critovici '607 patent and Carignani '827 patent are directed to methods and apparatus for processing of slurries with metallic constituents, and the Coleman '956 patent is directed to a method and apparatus for removal of pyretic sulphur from carbonaceous particles.

Accordingly, it is respectfully submitted that independent Claims 1, 26, 57, and 73, as amended, and the claims depending therefrom, include recitations that patentably distinguish the claimed invention over the cited references and that the rejections directed to these claims be withdrawn.

* * * * *

It is not believed that extensions of time or fees for net addition of claims are required, beyond those that may otherwise be provided for in documents accompanying this paper. However, in the event that additional extensions of time are necessary to allow consideration of this paper, such extensions are hereby petitioned under 37 CFR § 1.136(a), and any fee required therefore (including fees for net addition of claims) is hereby authorized to be charged to Deposit Account No. 16-0605.

Respectfully submitted,



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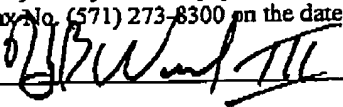
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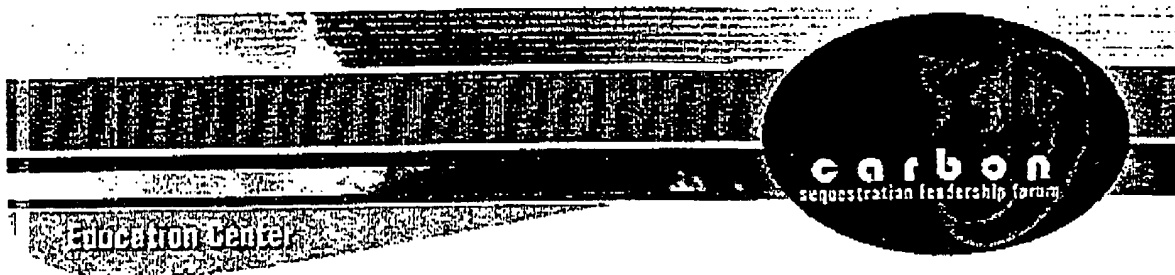
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EXHIBIT A



OVERVIEW | GLOSSARY | FAQ'S

Above-Ground CO₂ Storage: The carbon stored in plants, not including roots and soil. In a typical forest, 80% of the total carbon is above ground. Only 10% of the total carbon is above ground in grasslands.

Absorbent, Amine: Amines are a class of chemicals that are used to capture CO₂ and/or sulfur dioxide (SO₂) from gaseous process streams. Amines capture CO₂ from a gas by a chemical reaction in which the CO₂ becomes attached to the amine. Heat is required to reverse the reaction and release the captured CO₂.

Absorbent, Metal: Solid materials containing sodium or other metals that can chemically absorb and desorb CO₂ in a regenerable cycle. Leading concepts introduce adsorbent contacted to the CO₂ in a fluidized bed. Such systems have potential for low energy use per unit of CO₂ captured compared to conventional water-based amine absorbents, because they are dry and water does not have to be heated up and cooled down in the absorption/desorption cycle.

Acid Gas: Chemical species, principally oxides of sulfur (SO_x) and nitrogen (NO_x), contained in flue gas and other process streams that combine with water vapor or water droplets to form acid. Acid gases can corrode pipelines and other process equipment and confound CO₂ separation technologies, especially at temperatures low enough for water to condense.

Adsorbent, Carbon: Amorphous solid carbon materials (as opposed to diamonds) physically attract and bind CO₂ onto their surface and can be used to capture CO₂ from a gas stream. Amorphous carbon materials produced in different ways have different surface structures and different adsorption properties. Potentially, carbon absorbents can capture and release CO₂ with very little energy required because there is no chemical reaction involved.

Avoided GHG Emissions: A measurement of greenhouse gas (GHG) emissions reduction that takes into account the reduced capacity of power plants and other industrial facilities due to the addition of CO₂ capture systems. For example, if a capture system were installed at a power plant that emitted 100 units of CO₂ per year, and the capture system captured 90% of the CO₂ but reduced the power plant's output from 50 units/yr to 40 units/yr, the reduction in terms of avoided emissions would be 10/40 versus 100/50 - a reduction of 87.5%, which is less than 90%. Often avoided-emissions calculations assume a method of making up lost capacity. In the above example, if the lost capacity was made up with a power plant without CO₂ controls (100/50), then the new emissions would be 30 units CO₂ per year (10 + (10/50)*100), which gives an avoided emissions rate of 70 units CO₂ per year --- again less than the 90 units of CO₂ per year that are captured.

Bio-Accelerated Sequestration: A concept of using microbial organisms (microscopic plants or animals) with CO₂ in geologic formations to sequester the CO₂ and/or convert it to methane. A key challenge in this area is to identify microbial organisms that can survive the harsh subsurface conditions (i.e., 10,000 pounds per square inch (psi), 125°C, pH 3-10, and salt concentrations of 30% or more in water).

Brine: Any solution of water and salt (sodium chloride), usually containing other salts also. Ocean water contains 3% salt. Brines in underground formations can contain 20% salt or more. Brine must be desalinated before it can be used for drinking, and underground formations containing brines are not regarded as drinking water supplies.

Carbon Dioxide (CO₂): A colorless, odorless gas that is produced when animals (including humans) breathe or when carbon-containing materials (including fossil fuels) are burned. Carbon dioxide is essential to the photosynthesis process that sustains plant and animal life, however, it can accumulate in the air and trap heat near the Earth's surface (the "greenhouse effect").

Carbon Sequestration: The capture and storage of carbon dioxide and other greenhouse gases that would otherwise be emitted to the atmosphere. The greenhouse gases can be captured at the point of emission, or they can be removed from the air. The captured gases can be stored in underground reservoirs, dissolved in deep oceans, converted to rock-like solid materials, or contained in trees, grasses, soils, or algae.

CO₂ Capture: The removal of CO₂ from a process stream or from the atmosphere to produce a highly pure stream of CO₂ amenable for conversion or storage. CO₂ capture systems are assessed on the purity of the captured CO₂, the percent of total CO₂ that is captured, and the capital cost and energy use per unit of CO₂ captured.

CO₂ Enhanced CBM Recovery: It is common for coal beds to have methane trapped in pore spaces and adsorbed onto the surface of the coal. In the case of seams that are too deep for economical mining, this coal bed methane (CBM) can be recovered and sold. CBM recovery can be enhanced by injecting CO₂ into the coal seam, as CO₂ preferentially adsorbs onto the coal surface and displaces the methane. Nitrogen can also be injected into unmineable coal seams to enhance CBM production.

CO₂ Enhanced Oil Recovery: The injection of CO₂ into depleting oil reservoirs to recover additional oil beyond that which would have been recovered by conventional drilling. In the most common CO₂ enhanced oil recovery (EOR) method, miscible CO₂ EOR, CO₂ becomes dissolved in the crude oil and both causes the oil to swell and reduces its viscosity - which drives and enables the oil to slip through the rock formation toward the oil recovery well. At 200,772 barrels of oil per day in 2000, CO₂ EOR accounted for 5% of total U.S. oil production. It is estimated that 3,000 to 8,000 standard cubic feet of CO₂ remains sequestered in a formation for every barrel of enhanced oil recovered.

CO₂ Depleting Oil and Gas Reservoirs: Reservoirs that have been producing for a while using primary recovery methods, for which the rate of resource production is starting to decline. Economically viable production from such formations can be extended by methods to enhance production rates including water and CO₂ floods.

Fossil Fuel: Any naturally occurring fuel of an organic nature formed by the decomposition of plants or animals; includes coal, natural gas, and petroleum.

Geologic Formation: A contiguous underground material which is sufficiently homogeneous to be considered a single unit. Geologic formations with a certain structure and porosity present an

opportunity for underground CO₂ storage, as evidenced by existing formations which have been storing CO₂ for millions of years. Examples of formations with CO₂ sequestration potential include depleted oil reservoirs, depleted gas reservoirs, unmineable coal seams, saline formations, and shale formations.

Global Warming Potential (GWP): A measure of the magnitude of the heat-trapping effect resulting from the addition of 1 kilogram of a gas to the atmosphere relative to that of 1 kilogram of carbon dioxide. GWP is a function of two factors (1) the instantaneous heat-absorbing ability of the gas, and (2) the length of time that emissions of the gas persist in the atmosphere, on average. Gases differ substantially in both heat-trapping ability and atmospheric lifetime. For example, methane is over 100 times more capable of heat trapping than CO₂, but methane's average atmospheric lifetime is only 12 years, compared to CO₂ which persists anywhere between 5 and 200 years. Most GWPs are reported as the average heat trapping effect over 100 years. The 100-year GWP for methane is 23; the 100-year GWP for CO₂, by definition, equals 1.

Greenhouse Effect: The warming of the Earth's surface and lower atmosphere caused by the trapping of radiated heat, much the same way the coated window panes of an agricultural greenhouse keep heat inside the greenhouse. Several gases, such as carbon dioxide and methane, can keep heat from escaping from the Earth into space and are called "greenhouse gases."

Greenhouse Gas (GHG): A gas which does not absorb radiation of wavelengths in the visible light spectrum, but does absorb infrared (heat) radiation. In the atmosphere these gases allow energy from the sun to reach the earth's surface, but limit infrared energy (heat) from escaping. This effect is called radiative forcing. Greenhouse gases absorb 90% of infrared energy radiating from the Earth. Water vapor is the primary GHG, and CO₂ is the most important GHG emitted to the atmosphere as a result of human activities. CO₂ accounts for over 80% of the anthropogenic GHG effect. Other GHGs include: methane CH₄, ozone (O₃), CFCs (CFC-11, CFC-12, CFC-113), HFCs (HCFC-22) and nitrous oxide (N₂O), CCl₄, methyl chloroform, sulfur hexafluoride, trifluoromethyl sulfur pentafluoride, and perfluoroethane. Each gas has a different global warming potential and longevity in the atmosphere.

Hydrates: A hydrate is a naturally occurring, ice-like crystalline compound in which a crystal lattice of water molecules encloses a molecule of some other substance. The compounds are very dense and insoluble in water. CO₂ hydrates are being investigated for use in CO₂ capture and storage.

Membrane: A material that is selectively permeable to one or more chemical species and can therefore be used to separate that species from a gas stream. Selective separation is driven by the partial pressure difference across the membrane surface. Membrane materials are being developed for the separation of CO₂ from hydrogen, natural gas, and flue gas.

Measurement, Monitoring, and Verification (MM&V): MM&V is defined as the capability to measure the amount of CO₂ stored at a specific sequestration site, to monitor the site for leaks or other deterioration of storage integrity over time, and to verify that the CO₂ is stored and unharmed to the host ecosystem. MM&V capability will ensure safe permanent storage, reduce the risk associated with buying or selling credits for sequestered CO₂, and help satisfy regulators and local government officials who must approve large sequestration projects. MM&V will also provide valuable feedback for continual refinement of injection and management practices.

Micro-Seismic: Micro-seismic sensors detect sonic-bursts (sounds) generated by sudden small-scale slips/cracking, or changes in temperature, volume, pressure, or stress in, rock mass formations and geomaterials. These sensors can be used to monitor oil and gas reservoirs for deformation, cracking,

and other changes in condition.

Migration of CO₂: The movement of CO₂ through a geologic formation, driven by density or a pressure differential.

Mineral Carbonization: A process in which CO₂ reacts with magnesium or calcium oxide to form mineral carbonates. The mineral carbonates are unreactive solids - highly permanent carbon storage. Challenges include slow reaction rates and the large tonnage of mineral-rich earth that must be mined for each unit of CO₂ sequestered.

Ocean Fertilization: A concept for ocean sequestration in which infertile waters are seeded with iron or other nutrients to enhance the growth of plankton and consequently increase the uptake of CO₂ into the ocean waters.

Ocean Injection: A concept for ocean sequestration in which CO₂ is injected directly into the mid-or deep ocean waters, where it dissolves into the ocean water.

Ocean Sequestration: Storage of CO₂ in ocean waters. Oceans are an important part of the natural carbon cycle because they store, release, and absorb large quantities of CO₂ to and from the atmosphere. Research in this area is focused on learning more about the ocean carbon cycle, deep ocean ecosystems, and the safety and potential environmental impacts of CO₂ storage.

Ocean Combustion: An approach to fossil fuel conversion in which the fuel is combusted in pure oxygen rather than air, which is 78% nitrogen and 21% oxygen. Oxygen combustion systems exhaust a stream of highly pure CO₂ as an inherent part of their operation.

Ozone: A bluish, toxic gas with a pungent odor, formed by three oxygen atoms rather than the usual two. Ozone occurs in the stratosphere and plays a role in filtering out ultraviolet radiation from the sun's rays. At ground level, ozone is a major component of smog.

Post-Combustion Capture: A system for CO₂ capture from a fossil fuel conversion where the fuel is combusted in air and resulting CO₂ is scrubbed, absorbed, or otherwise captured from the flue gas, which is primarily CO₂ and nitrogen.

Pre-Combustion Capture: A system for CO₂ capture from a fossil fuel conversion where the fuel is decarbonized via gasification, pyrolysis, or reforming prior to combustion. The synthesis gas from decarbonization is primarily a mixture of CO₂ and hydrogen. The CO₂ is captured from the hydrogen before the hydrogen is combusted.

Reservoir: A subsurface, porous, permeable rock body surrounded by impermeable rock and containing oil, gas, or water. Most reservoir rocks consist individually or collectively of limestone, dolomites, or sandstone.

Saline Formations: Geologic formation of porous rock that is filled with brine.

Soil Carbon: Organic and inorganic carbon contained in soil. CO₂ is converted into organic carbon by plants during photosynthesis, and is then deposited in the soil through their roots and in plant residue. Organic carbon is found in the top layer of soil. Inorganic soil carbons are carbonates that form through non-biological interactions. They are a minor component compared to organic carbon.

Soil carbon sequestration occurs through direct and indirect fixation of atmospheric CO₂. Direct soil

carbon sequestration occurs by inorganic chemical reactions that convert CO₂ into soil inorganic carbon compounds such as calcium and magnesium carbonates. Direct plant carbon sequestration occurs as plants photosynthesize atmospheric CO₂ into plant biomass. Subsequently, some of this plant biomass is indirectly sequestered as soil organic carbon (SOC) during decomposition processes. Worldwide, SOC in the top 1 meter of soil comprises about 3/4 of the earth's terrestrial carbon.

Terrestrial Carbon Sequestration: The absorption and storage of carbon by vegetation and soils in terrestrial ecosystems.

Unmineable Coal Seams: Coal seams which are inaccessible and/or uneconomical to mine due to depth, coal quality, and technological or land use restrictions.